



The Mariners' Museum Web Site Wins "Addy" Award


In April 1998, The Mariners' Museum was awarded the "Addy" for web site design in the Mid-Atlantic Region. The award, sponsored by the American Advertising Federation (AAF), was for the three-state area of Virginia, North Carolina, and Virginia and highlights media/web site design excellence.

More than 60,000 entries were received in local competitions sponsored by the 220 AAF affiliate federations around the country, where the road to the American Advertising Awards begins each fall. The local winners proceeded to 14 regional competitions, with winners becoming eligible to compete in the national contest.

Visit The Mariners' Museum online at www.mariner.org.

See our National Marine Sanctuaries web page at www.sanctuaries.noaa.gov.

WWW

 **Monitor National Marine Sanctuary**
The Mariners' Museum
100 Museum Drive
Newport News, Virginia 23606-3759



Funding by the National Oceanic Atmospheric Administration

Printed on recycled paper with soy-based inks

From the Pilot House

The year 2000 was a busy and productive one for the *Monitor* National Marine Sanctuary. As reported herein, we conducted NOAA and Navy dive operations, resulting in stabilization of the *Monitor's* hull, the recovery of two large drive train components and other artifacts and the deployment of the huge engine recovery structure. We also enjoyed nearly 4 and one-half hours of prime-time national television coverage. We are very grateful to the Navy and all our other partners, whose names are mentioned in this issue, for helping make the current recovery efforts possible. We also are grateful to the Department of Defense Legacy (Resource Management) Program for granting nearly \$2 million to the Navy to support their diving and recovery efforts at the *Monitor* Sanctuary. The sanctuary staff would also like to thank Dan Basta and Craig McLean, director and deputy director, respectively, of the National Marine Sanctuary System. They have supported, assisted, and encouraged us in many ways.

Since returning from the last dive operation last fall we've kept busy helping the Navy plan an even more complex expedition for 2001. In fact, we will conduct seven expeditions to the sanctuary over a seven-month period—by far the most activity during any one year. By the end of July we hope the

Monitor's engine and a large segment of armor belt will be safely in storage at The Mariners' Museum. I hope you will log onto our Web site frequently this summer to follow our progress. It is going to be a long but very exciting year.

In closing, I must sadly acknowledge the departure of Dina Hill, our education coordinator and *Cheesebox* editor. Dina and I have known each other for more years than either of us cares to admit, and Dina was involved with the *Monitor* even before its discovery. She has been our archivist and "corporate memory," cherished employee and loyal friend. For years Dina and I were the only two employees at the *Monitor* office, so Dina performed tasks ranging from secretarial to educational to management. She still does. It's difficult to imagine how the office would have survived without her all these years. Although we will move ahead, as we must, the Sanctuary office will never be the same. Dina, we wish you fair winds and following seas.

Follow along with the *Monitor* 2001 Expeditions by visiting <http://oceanexplorer.noaa.gov/>.

John Broadwater, Manager

Non-Profit Org.
U.S. Postage
PAID
Newport News, VA
Permit No. 2041



Monitor National Marine Sanctuary Activities Report

CHEESEBOX

Volume XI, No. 1

April 2001



Monitor 2000: Paving the Way for Engine Recovery

The 2000 field season was the longest ever for the *Monitor* Sanctuary staff, beginning in late April and running through the second week in August with only a three-week break between the first and second phases.

As with past expeditions, *Monitor* 2000 was affected by adverse weather conditions, although not to the extent that we had anticipated. There were no major storms, just the notorious currents, rough seas and gusty winds that plague everyone who works in the dynamic environment of Cape Hatteras. We accomplished most of the goals established for the expedition, most importantly stabilizing the *Monitor's* hull with grout (cement) bags and deploying the 90-ton Engine Recovery Structure that will be used to support recovery of the *Monitor's* engine during *Monitor* 2001.

Follow along as we tell the story of *Monitor* 2000 and outline plans for future efforts.

Monitor 2000 was the next step in NOAA's long-range preservation plan for the wreck of the USS *Monitor* (see *Cheesebox*, Volume IX, No. 2 for details on the plan). The expedition consisted of two phases that were carried out by NOAA and Navy divers. In addition, prior to the beginning of the Navy dives, the Research Vessel *Sea Diver* and three-man submersible *Clelia* were used for close-up observations and documentation of the wreck. During Phase I and Phase II NOAA dives, technical divers and technicians from the Cambrian Foundation and the National Undersea Research Center/University of North Carolina at Wilmington (NURC/UNC-W) used NOAA Trimix I to carry out a variety of tasks. Archaeologists and divers from East Carolina University's Program in Maritime Studies also participated in the NOAA dives. Divers from



This enhanced photomosaic, made from captured video images, shows the *Monitor's* stern, port armor belt, and turret. (Jeff Johnston, *Monitor* Collection, NOAA).



The Engine Recovery Structure (ERS) was positioned over the side of the barge and slowly lowered to the *Monitor*. It will be used in recovering the *Monitor's* engine later this year (*Monitor* Collection, NOAA).

One of the primary Navy objectives was to provide realistic training opportunities for their divers.

Phase II of the expedition was designed with overlap between Navy and NOAA dives. Each group had separate tasks but the NOAA divers could design their daily objectives to render assistance to the Navy as appropriate.

Overall expedition goals were designed for maximum flexibility and to make the most of days when divers were able to work at the wreck. Goals for the Phase I NOAA dives, carried out in April and May, were as follows:

- Remove soft fouling growth (not concretion) from engine, and excavate a test pit at the base of the engine to expose main steam pipe
- Document, through drawings, measurements and photography, the following areas:
 - Area beneath the hull, particularly

the Navy's Mobile Diving and Salvage Unit-Two (MDSU-2) were on site for approximately one month during Phase II to carry out specific tasks and recover large items as appropriate.

continued on page 2



aft of midships, where stabilization will take place

- Lower hull, machinery space and fire room, with particular attention to the configuration of the engine, its attachment to the hull and its support from above and below.
- Map and recover exposed artifacts that may be damaged or destroyed by the action of currents, the collapse of portions of the hull, or by the planned hull shoring and recovery activities.
- Test the difficulty of removing rivet heads and a hull plate along the lower hull over the fire room or engine room.
- Recover the recording current meter placed near the bow in 1999.

Goals for the Phase II NOAA dives, carried out from mid-July to mid-August, included:

- Document, through drawings, measurements and photography, the following areas:
 - Area beneath the hull, particularly aft of midships, where the hull was shored up with grout bags.
 - Turret and its area of contact with the inverted hull.
 - Machinery space, with particular attention to the engine room area to be affected by Navy recovery activities.
 - The Engine Recovery Structure (ERS or "bridge"), placed over the engine room during the Navy's Phase II dives (see below).
- Map and recover artifacts that were exposed by the action of currents or the hull shoring and recovery activities.

Goals for the Navy's Phase II operations in June and July included:

- Stabilize the *Monitor's* hull by installing grout bags beneath the raised portion of the hull, forward of the turret.
- Excavate at the base of the engine to expose piping, attachments, and the interface between the engine and overhead structure.
- Map and recover artifacts from the machinery space.
- Move or remove the skag, if necessary, to prevent its damage during engine rigging and recovery.
- Place the ERS over the wreck to facilitate engine rigging and recovery.
- Rig and, if possible recover, the steam engine and associated hull structure.
- Provide an opportunity for realistic training in mixed gas diving and salvage operations of MDSU-2.
- Conduct an at-sea evaluation of revised

USN Surface Supplied Helium-Oxygen Decompression Procedures.

- Conduct a post-mission survey and acquire additional engineering data in the vicinity of the turret, as requested by engineering personnel, for use in refining the turret recovery plan.
- Conduct certification dive with the EXO-26 Diving Apparatus using helium-oxygen as the breathing medium.

Although recovery of the *Monitor's* engine was included in the goals for the Navy dives, project participants knew from the outset that the engine could be recovered only if there were no days lost to weather and all of the other goals were met in record time. As always when working in the Graveyard of the Atlantic, the weather was not particularly cooperative and everything took a little longer than that we had hoped. It became apparent mid-way through the Navy dives that there would not be sufficient time to complete the tasks that were prerequisite to engine recovery.

Phase I NOAA Dives

On April 26 when, despite gale warnings and predictions of 11-foot seas, the Research Vessel *Cape Fear* arrived at Cape Hatteras. Members of the NOAA dive team had begun arriving the previous day. Training or "tune-up" dives are always conducted prior to beginning NOAA dives on the *Monitor* because of the *Monitor's* depth of 235 feet and frequent strong currents.

Adverse weather conditions complicated completion of the training dives but on April 30 the last "tune-up" was successfully carried out. The first dive on the *Monitor* was made on May 1 in relatively calm seas (1 to 2 feet) and warm, blue Gulf Stream water. The team secured a buoy line to a bottom anchor, surveyed the wreck, and recovered the current meter left at the site last year. The meter was later taken to Old Dominion University, Norfolk, VA, where the data was downloaded, providing information about water temperature and current direction and speed at the *Monitor* since August 1999.

The next two days were lost to weather but improved conditions on May 4 allowed divers to record video footage of the steam engine and controls and the starboard side of the engine room, turret, and gun ports. They recorded measurements in the engine room that will help determine how much collapse has taken place and took measurements outside the hull to determine if the seabed around the wreck is level enough for the planned engine recovery operation. They also placed reference markers at 10-foot intervals along the armor belt between the turret and

the midships bulkhead. These reference markers will orient Navy divers.

On May 5 divers recorded video footage of the forward face of the steam engine and the aft entrance to the engine room, beneath the hull where the Navy was to place grout bags, and behind the turret, where there is a hole in the deck in the engine room. They also took measurements inside the engine room and recorded depth measurements on the hull.

Despite worsening conditions the next day, divers deployed and assembled dredging



The Research Vessel Cape Fear provided support during the NOAA dives. The vessel is based at the University of North Carolina at Wilmington (Monitor Collection, NOAA).

equipment on the bottom and recorded measurements along the *Monitor's* armor belt and lower hull. They also cleared soft marine growth from areas around the steam machinery and searched for seams in the lower hull plating.

Divers working in the fire room found that marine growth covering the *Monitor* was tougher than expected. They removed soft coral and sponge to provide a better look at the forward end of the engine and to help identify fragile components that will need to be removed before engine recovery begins. A fragment of hull framing and a small section of hull plating were recovered and used to test cutting equipment that was to be utilized Phase II.

The next day, May 7 and day 12 of the expedition, dive teams working in much improved conditions videotaped the engine room area and used an airlift to excavate beneath the engine. They also removed more sponges and coral from the front of the engine to expose controls and gauges and inspected the lower hull to locate seams between the hull plates.

The airlift proved to be very ineffectual at clearing out the layer of silt and debris at the base of the engine. It appears that iron debris, coal, and deck plates have fallen to the area around the engine, and that, over the

years, iron oxidation products have cemented the whole layer together. Eventually this layer must be removed to provide access to the engine.

On May 8 divers recorded video footage of the forward face of the steam engine and sketched the face of the engine and valve chest. The sketches will be used to develop a relatively complete image of the engine face. Divers also attempted to locate and clean the seams between hull plates on the lower hull, directly over the engine. They continued documentation of the engine room and efforts to expose hull plate seams. The divers had planned to clean one or more seams, then attempt to partially remove a hull plate to determine how difficult the process would be. However, they could not remove a single rivet.

Adverse weather forced cancellation of diving for the next three days. On May 12, the final day for this phase, diving was again possible. Divers recorded video of the starboard side of the engine, the starboard engine bulkheads, the port side of the engine and the port engine bulkheads. They also mapped the location of gauges and mercury tubes in the engine room.

This phase of *Monitor 2000* ended on a high note when divers recovered the *Monitor's* bilge strainer. With the exception of the turret, the bilge strainer is probably the most photographed piece of the *Monitor*. It was located in a prominent position on the aft-most engine bulkhead. During this expedition, divers found that it had broken loose from its attachment points and could possibly fall into the wreck.

Phase I NOAA operations were highly successful. Despite the loss of several days to weather, divers accomplished most of their objectives and recorded video and other information that will assist in final planning for recovery of the *Monitor's* engine.

Phase II Submersible, Navy and NOAA Dives

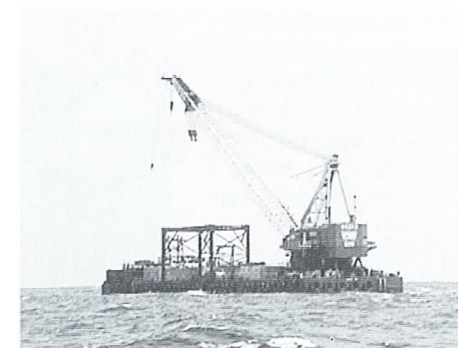
Planned Navy operations for Phase II of *Monitor 2000* required a support platform with sufficient deck space to accommodate personnel, equipment, and the massive ERS. On June 17 the 300-foot Weeks 526 derrick barge arrived at the Naval Amphibious Base, Little Creek, VA (near Norfolk) to begin the slow process of conversion to support Navy diving, stabilization, and recovery operations. Personnel from MDSU2 immediately

began clearing the deck and loading and securing equipment. They secured portable modules for berthing and feeding the nearly sixty personnel who will be aboard throughout the mission. There were also modules to serve as galley, dining, laundry/shower, sewage processing, drinking water production and storage, electrical power generation, and other functions. In addition, the barge housed a small crane, the Navy's dive system, a cement mixing plant, cement storage, and the 90-ton ERS. The most striking feature of the barge was a crane with a 300-foot boom and 350-ton lifting capacity.

As the barge was being readied for *Monitor 2000*, the Research Vessel *Sea Diver* arrived at the *Monitor* National Marine Sanctuary to begin operations with the three-person submersible *Clelia*. The *Sea Diver* and *Clelia*, owned and operated by Harbor Branch Oceanographic Institution, spent several days at the *Monitor* site, allowing Sanctuary staff ample opportunity to study the current condition of the wreck and refine plans for Phase II of *Monitor 2000*. The *Sea Diver* made a total of six dives to the *Monitor*, recording high-resolution video of the wreck, before weather conditions deteriorated dramatically.

The barge left the Naval Amphibious Base for the *Monitor* Sanctuary at midnight on June 23, under tow by the seagoing tug *Katherine*. Plans called for the barge to begin setting up its eight-point mooring upon arrival in the Sanctuary. However, the barge reached the Sanctuary at first light on June 25 to find deteriorating weather conditions, making it impossible to moor the barge over the *Monitor*. The barge sought shelter closer to shore as the *Sea Diver* headed for safe haven at Morehead City, NC. When updated weather reports the next morning predicted high seas for the next two to three days, the barge and tug got underway for a return trip to Little Creek.

The RV *Sea Diver* and the Navy barge returned to the *Monitor* Sanctuary on June 30 to much improved conditions. While *Clelia* conducted additional surveys of the *Monitor*, the barge began the long process of setting up the eight-point mooring,



This 300-foot Weeks barge served as home for Navy and NOAA personnel involved in the Navy phase of Monitor 2000 (Monitor Collection, NOAA).



assisted by the tug *Katherine*. Mooring operations were completed the following day, after which *Clelia* carried out another survey dive.

On July 1 Navy personnel finished setting up and adjusting the barge mooring. *Clelia* made one survey dive and two additional dives on the next day, recording nearly four hours of video of the wreck. Following the last dive, the RV *Sea Diver* and *Clelia* departed the Sanctuary for the Harbor Branch facility in Fort Pierce, FL.

Navy dive operations also began that day with three sets of dives to the *Monitor*. The first priority was to complete stabilization of the *Monitor's* hull and by July 4, four specially



The Research Vessel Sea Diver and three-person submersible Clelia were on site for several days during Monitor 2000. The vessel and submersible are owned and operated by Harbor Branch Oceanographic Institution of Fort Pierce, Florida (Monitor Collection, NOAA).

designed grout bag frames had been placed beneath the *Monitor's* hull, pinned to the seabed with metal rods, and awaiting being filled with grout. The final three grout bags and frames were installed the next day. Strong currents had created an uneven seabed in the stabilization area, which had to be leveled before the grout bags could be filled.

Navy divers leveled the stabilization area and repositioning the grout bags. A series of survey markers was secured to the *Monitor's* hull to help guide the placement of the ERS. Over the next several days, as Navy divers filled the grout bags, plans were made to take advantage of improving sea conditions and deploy the ERS.

Final preparations for deploying the ERS began on July 14, when weather was almost ideal. After reviewing final procedures one last time the ERS was lifted off the deck, swung around to the stern of the barge, and lowered into the water. Finally, at exactly 5:30 p.m., after a slow descent during which the barge and crane were adjusted to the precise position, the ERS touched down on the



seabed. Positions for the ERS legs were indicated by large markers placed on the bottom in predetermined locations. Cameras mounted on the ERS allowed surface personnel to see where the ERS was in relation to the wreck as it was lowered to the bottom. A Remote Operated Vehicle documented the position from the bottom.

On July 17 the second team of NOAA divers arrived in Hatteras as Navy divers continued filling grout bags. NOAA divers conducted their first training dive on a shallow site near the *Monitor*.

On July 19 Navy divers completed a visual and video inspection of the stabilization area and made two inspections in and around the engine room. They also surveyed the ERS before severe thunderstorms forced termination of dive operations for the day. The NOAA team, aboard the R/V *Cape Fear*, successfully completed a 180-foot training dive.

On July 21 the mission reached another major milestone: the stabilization phase of the mission was completed when Navy divers installed and filled the final grout bag. Diving from the R/V *Cape Fear*, NOAA divers made two sets of dives, mapping the location of the ERS and inspecting the final grout bag while it was being filled.

Navy divers completed four sets of dives the next day, all concentrating on the lower hull and engine room area. The last dive, which did not end until after midnight, resulted in the removal and recovery of a sample of lower hull plate. The plate and rivets were in remarkably good condition, compared to some other parts of the hull, offering encouragement that the engine and supporting hull and framing can be recovered as a single unit. NOAA divers continued mapping, photography and survey tasks.

On July 26 Navy divers recovered a section of engine room floor plate. One surface of the plate has a high-relief pattern of diamonds, making the plate virtually nonskid. The pattern is identical to engine room plate from another Civil War period ship, the CSS *Nashville*. On July 27, Navy divers recovered a section of propeller shaft with a coupling and stuffing box. This section can be reattached to the section recovered with the propeller in 1998.

The Navy phase of *Monitor* 2000 ended

on Friday, July 28, with the recovery of the *Monitor's* skeg (the beam that supported the rudder and propeller shaft). The 28-foot-long, 7000 pound skeg was lifted from the water at 11:00 A.M. and placed on the deck of the barge.

To permit the Navy to begin recovering the eight anchors that moored the barge in place, NOAA divers offered to complete several Navy "housekeeping" tasks, including recovering tools and cables from the seabed. By 8:00 p.m. all eight anchors—weighing between 6,000 and 20,000 pounds each—had been retrieved and the barge got underway for Norfolk, the first time the barge had moved from its position over the *Monitor* since being



This section of floor plate recovered from the *Monitor's* engine room has a raised diamond pattern that rendered the surface virtually skid-proof (*Monitor* Collection, NOAA).

moored on June 21. Sanctuary staff went ashore at Hatteras to oversee completion of the NOAA dives.

With the exception of August 8, when rough seas forced cancellation of operations, divers were able to reach the wreck every day through the last day of *Monitor* 2000 and completed a number of tasks. They carried out an excavation within the engine room. They also mapped the fire room floor and turret base in preparation for excavations in those areas. They mapped the steam condenser, which was much more accessible following the removal of the skeg and shaft section. They also removed quite a bit of modern debris—cable, rope, metal fragments, and tools—left behind from the Navy phase of the expedition.

As mapping in the engine room continued, other NOAA divers excavated down to the main steam pipe between the boilers and engine. They also made key measurements to five gauges on the engine valve chest. One team videotaped several artifacts in the stern: what appeared to be a ceramic bowl with a handle, a crushed lantern, a brass ring

This intact white ironstone pitcher was recovered from the wreck during the *Monitor* 2000 Expeditions. *Monitor* Sanctuary staff is researching the maker's mark found on the bottom (*Monitor* Collection, NOAA).



that may be associated with the lantern, and a cylindrical lead weight that appears to be identical to those recovered last year. The brass ring was recovered during this set of dives.

Excellent video of the engineering space was recorded, including both sides of the engine, the valve chest and the condenser. The video will facilitate a complete map of the engine room and engine. The airlift and other equipment that had been left on the bottom were recovered.

August 10, the last day of NOAA dive operations, brought another day of strong currents over the *Monitor*. Divers recovered an intact ironstone pitcher that had been excavated by a oyster toad fish, who was apparently using the pitcher as a home. They also recovered a ceramic knob from a drawer or cabinet and half of a brass hinge.

The success of *Monitor* 2000 was due in large part to a great team, made up of skilled people from many diverse organizations. A list of project participants and sponsors follows.

And we are on to *Monitor* 2001!

Monitor 2000 Project Participants and Sponsors

U.S. Navy (naval Sea Systems Command, Mobile Diving and Salvage Unit Two)
Cambrian Foundation
Department of Defense Legacy Resource Management Program
Harbor Branch Oceanographic Institution
Hatteras Landing Marina
The Mariners' Museum
Maritime Studies Program, East Carolina University
National Geographic Society
National Undersea Research Center, University of North Carolina at Wilmington
Newport News Shipbuilding
Oceaneering International, Inc.
Research Vessel *Cape Fear*/
University of North Carolina at Wilmington
Sartek Industries
U.S. Army Transportation Division, Fort Eustis
U.S. Coast Guard, Group Cape Hatteras



Y2K: A Milestone in the *Monitor's* Propeller Conservation

The *Monitor's* propeller has made considerable progress through the conservation process but it still has an estimated two more years to go in its electrolytic bath. Conservation began in August 1998, less than a month after the three-ton propeller and shaft were recovered.

A major hurdle in the treatment was how to safely remove the propeller from the drive shaft. Historic plan information and a series of ultrasound tests made on the hub indicated that there was a large cavity inside the hub. Because of the porous nature of iron, it was assumed that corrosive salts had penetrated to the very heart of the artifact. The propeller and shaft had to be separated to assure the complete treatment of all surface areas.

There was no "hub nut" on the shaft holding the propeller in position and removal of marine growth during conservation revealed no pins or set screws in the hub. There are two tapered keys about 120 degrees apart that assured alignment and kept the propeller from spinning on the shaft.

Historical information offered little insight into the assembly process, but did provide pertinent details. The propeller hub is 2 feet, 4 inches long, 18 inches in diameter on the forward end and 14 1/2 inches on the aft end. The interior diameter of the propeller hub at the forward side is 9 inches and tapers to 8 3/4 inches where the tail shaft exits the hub.

To set the propeller on the shaft, we are fairly certain that the 9-foot-diameter casting was heated to a suitable expanding temperature and the shaft section was set into it. The two keys assured alignment. The tolerances between the shaft and the hub appear to have been approximately 0.15 inches. As the propeller cooled, a very tight fit was produced. On concern was how to separate the two without damaging the propeller.

After liberal consultations with a variety of experts in the ship husbandry field, two options were considered. The first called for the preservation of both the shaft and propeller, and the second was, if necessary, to sacrifice a section of the shaft to preserve the propeller. It should be noted that the most historically significant of the two is the propeller, which was designed by the *Monitor's* inventor, John Ericsson. The shaft, which although important for its association with the *Monitor*, was a common item.

The first separation option involved extraction of the keys. The consensus was that

if the keys could be removed, the pressure between the shaft and the hub would lessen and the propeller could be removed with minimal stress.

Collins Machine Works of Portsmouth, VA, was selected to do the work because of their vast experience in the marine industry. Their plan involved drilling about 6 inches into the keys and tapping the holes with coarse threads to allow a long threaded rod to be inserted into the keys. An aluminum shield was fabricated to fit the face of the hub to prevent marring. Once everything was drilled and tapped, a hydraulic puller was attached to a threaded rod inserted in one of the keys.

It was hoped that with minimal pressure,

*"As the concretion was peeled away, details of the *Monitor's* propeller came vividly to life. These details have provided some insight about the fabrication process for Ericsson's screw propeller."*

the key would gently slide out of the hub. It did not.

When pressure was applied bubbles appeared in the gaps around the key. An old-fashioned taste test verified that salt water had indeed penetrated deep into the propeller and probably filled the reservoir inside.

When the hydraulic pressure reached about 30 tons, the protective aluminum plate covering the hub cracked. The pressure was relieved and the rig disassembled to check the progress. The key had not moved and it was found that the aluminum plate was being pushed into the graphitized surface of the cast iron propeller. This method was abandoned.

The next option called for cutting off the propeller shaft on both sides of the hub. With the shaft removed, the propeller could be placed in a horizontal position and a series of holes, each successively larger, would be drilled through the shaft until there was a 3-inch opening. A milling machine could then be set up and the shaft could be reamed out from the inside.

Two special steel plates were designed and fabricated to fit over the fore and aft sides of the shaft and snug up against the propeller itself. These 4-foot-diameter plates allowed the propeller to be securely supported while the shaft was being cut away. They would also provide the means to move the propeller as necessary without rise of damage.

The Navy's Mobile Diving and Salvage Unit Two (MDSU2) was asked if they could supply equipment and men to cut the shaft.

MDSU2 was the unit that recovered the propeller for NOAA in 1998. They welcomed the opportunity to assist and sent the same saw that had been used to cut the shaft in 1998 and some of their divers who had been involved in the propeller recovery. Using this saw, the tail shaft was severed near the hub in 46 minutes and the main section of shaft was severed in 62 minutes.

After the shaft was removed, the propeller was laid over and the process of drilling into the section of shaft inside the propeller hub began. After several days of slow, tedious work, the opening was large enough for the reaming to begin. This was another slow process, requiring more than a week to com-

plete. A hammer and soft punch was used to tap the keys out of their slots and the remaining section of propeller shaft slid out of the hub with ease.

All of the sections of the shaft and propeller were returned to the treatment tank and the electrolytic process for approximately two more years.

What's Been Revealed?

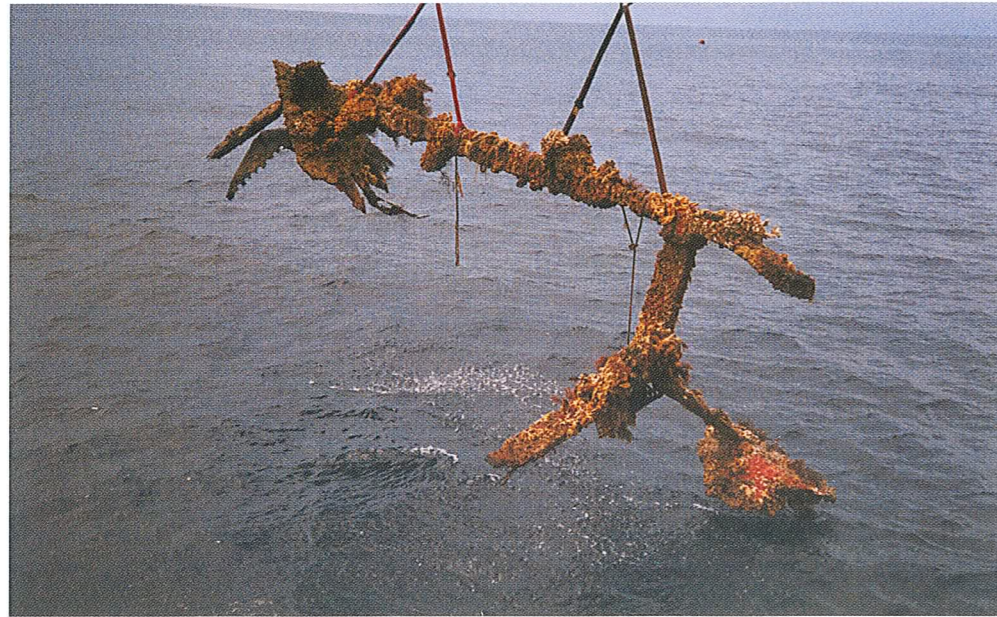
One of the benefits of allowing the electrolytic reduction process to decide when the covering concretions are ready to come off on an object in treatment becomes very clear when looking at the *Monitor's* propeller. With time, the thick calcium concretion covering the artifact was loosened from the surfaces of the propeller, preserving the highly graphitized (and in some instances very soft) surfaces. As the concretion was peeled away, details of the *Monitor's* propeller came vividly to life. These details have provided some insight about the fabrication process for Ericsson's screw propeller.

Scrape marks on various surfaces of the propeller were also revealed as a result of the conservation process. These marks were probably left in the casting by workers at the Washington Navy Yard who scrapped fouling from the *Monitor's* hull when she was sent there for repairs in October 1862.

By far the most intriguing discovery was the initials "WK" chiseled into one of the blades. Did William Keeler, the *Monitor's* Paymaster, leave his mark on history?



2000 Monitor Expedition



The Monitor's skeg was one of several large items recovered during the 2000 Expeditions (Monitor Collection, NOAA).



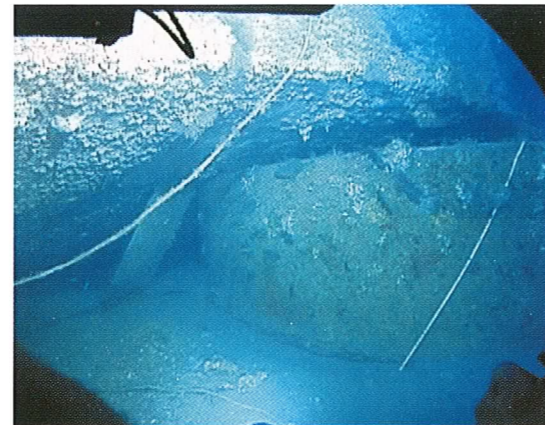
A large section of the Monitor's propeller shaft sits on the deck of the barge following recovery. A section of bulkhead is attached to the shaft (Monitor Collection, NOAA).



As always, the ever-challenging Hatteras environment provided several days of rough weather during the Monitor 2000 Expeditions (Monitor Collection, NOAA).



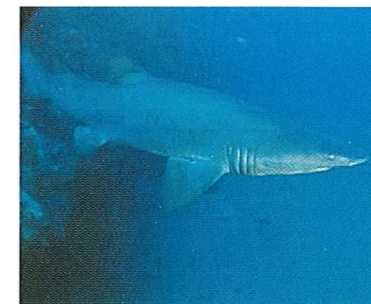
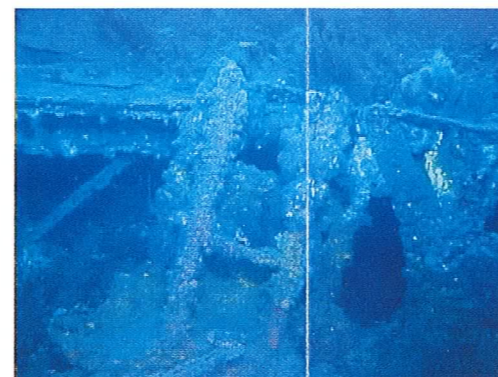
This group shot shows the members of the NOAA dive team (Monitor Collection, NOAA).



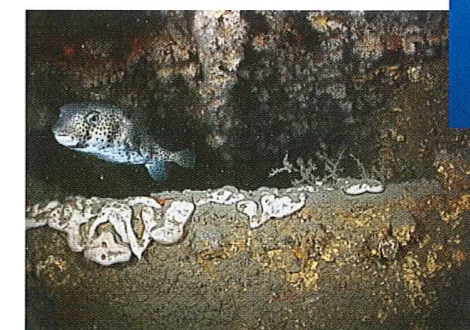
The Monitor's turret appears to be in good condition but deck plates aft of the turret have separated from the wreck and can be seen hanging to the bottom sediment (Monitor Collection, NOAA).



The H-shaped midships bulkhead support is clearly visible in the wreck. The edges of lower hull plates, once lying atop the bulkhead, slipped behind the support as the lower hull collapsed (Monitor Collection, NOAA).



Divers to the Monitor were greeted by the local wildlife (Monitor Collection, NOAA).



Unlike the stern, the Monitor's bow has remained relatively unchanged over the past decade. The large growths are corals and sponges (Monitor Collection, NOAA).





1999 Field Activities: Laying the Groundwork

Two expeditions to the *Monitor* were conducted during the 1999 field season, in June and August. Surface and bottom conditions were relatively good, and almost all mission objectives were accomplished. Like the 1998 expedition, goals for the 1999 expeditions were designed to complete tasks described in the *Monitor* long-range preservation plan that NOAA submitted to Congress in 1998.

The first phase of field activities was carried out from June 17 through June 27. Working from the Navy salvage ship USS *Grasp* (ARS 51), Navy divers focused on a survey and assessment of the lower hull and engineering space to facilitate plans for shoring the hull and recovering the engine.

This mission was carried out by the Marine Sanctuaries Division of NOAA; Office of the Supervisor of Salvage and Diving, Naval Sea Systems Command; Combat Logistics Squadron 1; Mobile Diving and Salvage Unit Two (MDSU2); and The Mariners' Museum.

Mission objectives included 1) surveying the engine room area; 2) acquiring geotechnical data in the vicinity of the turret; 3) mapping exposed objects in the stern debris field; 4) providing an opportunity for realistic training in mixed-gas diving and salvage operations for personnel from the USS *Grasp* and MDSU2; and 5) assessing the effectiveness of Navy surface-supplied, mixed-gas diving methods.

The second phase of 1999 *Monitor* operations was carried out from August 1 through August 26 and included NOAA's Marine Sanctuaries Division, the NOAA Diving Center, the National Undersea Research Center at the University of North Carolina at Wilmington (UNC-W), the R/V Cape Fear from UNC-W, the Cambrian Foundation, and The Mariners' Museum. The primary objective was to continue documentation of the stern and machinery spaces and beneath the hull and recover small artifacts that might be lost or damaged if left on the bottom.

Stabilization and Engineering Mission, June 1999

Navy divers made a total of twenty-nine working dives from the USS *Grasp*, which was secured over the wreck on a four-point moor. Divers noted that a thick layer of silt that had built up in and around the wreck prior to the 1998 expedition was still there. Despite the silt, unprecedented video footage of the *Monitor's* engine and related machinery was recorded by Navy divers. This close-up examination confirmed that the engine is still bolted to the frames, although the entire lower hull assembly has dropped so that the engine has settled so that the engine is now resting on sand under the hull.

Navy combat photographers filmed the engineering space from underneath the wreck. One of the photographers worked his way almost completely around the turret to video the main steam cylinder for the *Monitor's* engine. He also located the condenser. The video showed that much of the deck under the engineering space has collapsed.

The photographers recorded video and still photographs around

and inside the *Monitor's* galley and inside the fire room. An excavation was conducted around the outside of the turret to determine the condition of the rifle shield, a chest-high ring of 1-inch boiler plate iron constructed to fit inside the rim of the inverted gun turret to protect men on the turret from fire. The rifle shield is completely buried in the sand, along with approximately 3 feet of the turret. The excavation showed that the rifle shield is intact, at least in the area where the excavation took place. The rifle shield and attached awning stanchions will make recovery of the turret more difficult.

Artifacts recovered during this expedition included four small lead disks, each with a hole in the center, lying near the propeller shaft. Three were concreted together, making them too heavy for the diver to handle, but the fourth was recovered. On the underside of the recovered disk was a flattened copper can or cup with a rolled lip. The remaining three disks were recovered with a lift bag.

The lead disks are 7 inches in diameter and 1 1/2 inches thick with a 3/4-inch-diam-

eter hole in the center. Each weighs approximately 27 pounds including its concretion. The purpose of the disks is not known.

Divers also recovered a 1 1/2-foot length of copper pipe that may be part of the *Monitor's* radiator system. The pipe has a threaded flange on one end. As with all artifacts recovered from the *Monitor*, the material recovered during the June expedition was transported to The Mariners' Museum in Newport News, VA, for conservation and eventual exhibition.

Monitor Research Expedition, August 1-26

The second phase of *Monitor* operations for 1999 lasted for nearly the entire month of August, with the first week given over to training dives. The first group divers reported that part of the thick layer of silt covering the wreck during the June expedition had disappeared, exposing the wreck more clearly. Divers documented a large segment of deck plating that has partially separated from the wreck about halfway between the midships bulkhead and the pilot house. This section of deck plating may have also been documented during the 1979 NOAA expedition. There is a deck light embedded in the deck plating. Using hand-held video, divers documented this feature and the 4-foot-by-6-foot hole that resulted from the separated plating. Divers observed a ceramic wash basin, still in the shelf in which it was secured, adjacent to the hole in the deck. The basin could not be recovered because of deck plates that obstructed access.

Portions of the wreck were documented by divers using digital video cameras. The engineering space was recorded from the port and starboard sides. The bilge strainer, the yoke assembly that connects to the condenser, the port armor belt and the aft end of the engine.

A recording current meter was deployed approximately 20 feet off the *Monitor's* bow. It recorded water temperature as well as current direction and speed until recovered during the 2000 expedition.

Divers conducted a small test excavation at the base of the turret to determine the condition of the rifle shield that was installed on the *Monitor* in November 1862 to protect the crew from sharpshooters on shore. An excavation conducted during the 1998 expedition, in another area at the base of the turret, indicated that the rifle shield had partially collapsed. Excavations conducted in June and August of this year indicated that at least part of the rifle shield is intact. Divers conducting the excavation reached the top of the

inverted turret beneath approximately 3 feet of sand and were able to measure the 7-inch "lip" to which the rifle shield was attached. They then uncovered 2 to 2 1/2 feet of smooth, vertical metal beyond the turret lip, which must be the rifle shield.

Several small artifacts were recovered. These include two intact bottles, a clear glass apothecary bottle approximately 3 inches in diameter and 5 1/2 inches in height, and a 6-inch-high octagonal US Navy mustard bottle. Divers also recovered a slat from the head of a small wooden cask and a 16-inch-diameter copper hoop possibly from the same cask. All artifacts were taken to The Mariners' Museum for conservation. Two small wood samples were also recovered for analysis, one from a deck beam and the other possibly from a deck plank.

Late-breaking News!

The NOAA dive team just returned from Phase I of *Monitor* 2001 (March 26 to April 11). In addition to obtaining much-needed survey information, the team recovered sixteen artifacts from the wreck of the *Monitor*. Among them was this brass handle from a Sharps and Hankins bayonet. Readers may recall that in the 1998 issue of *Cheesebox* we reported the recovery of a Sharps and Hankins butt plate.

Other artifacts recovered included one intact chimney for a whale oil lamp and several broken chimneys, a brass heat shield for an oil lamp, a brass machinery fitting, several condiment bottles and an intact white ironstone saucer. The artifacts are currently undergoing documentation and conservation at The Mariners' Museum in Newport News, VA. Phase I NOAA dives included the *Monitor* Sanctuary manager and historian and divers from the Cambrian Foundation, the East Carolina University's Program in Maritime Studies, and the National Undersea Research Center at the University of North Carolina at Wilmington.



NOAA and Partners Plan for 2001 Engine Recovery

Planning for *Monitor* 2001 got underway with several meetings between NOAA, the Navy, and The Mariners' Museum. Tentative plans call for the field season to begin in April, when NOAA and the Navy complete work at the site that will be required before the engine can be recovered. Tasks include clearing sediment from the engineering space, separating the engine from its various pipes and connections, and reinforcing the hull supports that were installed last year.

The second phase of Navy operations will begin in June and run for 30 to 60 days, depending on the dive system and team size. Using a barge similar in size to the one used for *Monitor* 2000, Navy

divers will rig and recover the engine. Other components from the engineering space, such as the condenser, may also be recovered.

Once recovered, the engine will be barged to the Hampton Roads area where the Army Transportation Division from Fort Eustis will assist in getting it to The Mariners' Museum for documentation, conservation, and eventual exhibition and interpretation.

Smaller artifacts, including wrenches, shovels, and tubes and gauges may also be recovered. Time permitting, a section of hull and armor belt will be removed to provide access to the turret, which we hope to recover in 2002.

On October 24 the award-winning science series NOVA premiered its new season on public television stations nationwide with a one-hour documentary on the USS *Monitor* and the *Monitor* National Marine Sanctuary. Titled "Lincoln's Secret Weapon," the program focused on the 1998 *Monitor* expedition during which the ship's 9-foot-diameter propeller was recovered. For a VHS copy of the program, call 1-800-949-8670. The item number is WG-2710 and the price is \$19.95.

On December 11 the History Channel aired a two-hour program on the US *Monitor* and the *Monitor* National Marine Sanctuary. The program featured interviews with *Monitor* Sanctuary staff, US Navy personnel, curators from The Mariners' Museum, and others familiar with the history of the famous ironclad and current recovery efforts.

The Mariners' Museum has published a collection of letters written by *Monitor* crewman George Geer. Titled *The Monitor Chronicles*, the book is available from the Museum Shop by calling (757) 591-7792. The cost is

\$35.00. Geer, who served aboard the *Monitor* as a first-class fireman until the ship sank in December 1862, wrote frequent letters home to his wife Martha. His letters detail life aboard the ironclad as seen through the eyes of an enlisted man. The volume was edited by William Marvel.

David A. Mindell of the Massachusetts Institute of Technology has published *War, Technology, and Experience aboard the USS Monitor*. This book investigates how the *Monitor's* crew coped with the stresses of life aboard this new kind of ship and how the technology of the *Monitor* was viewed by the country. It is available from major bookstores.

Stay tuned to the *Monitor* Sanctuary web site for announcements of new publications available from the Sanctuary office. We are currently working on new Sanctuary and *Monitor* Collection brochures, bookmarks, and an updated information book, all of which will be available by September 2001. We will have a new Sanctuary poster as well. *Monitor* paper models are still available in limited quantity.





Historical Note

Our historical note for this issue was taken from an article that appeared in the Chicago Tribune on January 4, 1864. We found it interesting because of it involves monitor-type vessels and because it describes the gear and diving activities of a man hired to clean the bottoms of the monitors without hauling them out of the water. We thought our readers might enjoy knowing that there were divers in the Civil War and how it was done before the invention of scuba gear.

The Divers and the Monitors

During a recent visit to Port Royal, I witnessed with considerable interest the operations of the divers employed to clean the bottoms of the monitors, and perform other operations under the water. Messrs. Joseph H. Smith and James B. Phelps have a contract with the Government for the performance of this work, and have been of great use here.

Their principal diver - appropriately named Waters - is so used to this work that he has become almost amphibious, remaining for five or six hours at a time under water. A man of Herculean strength and proportions, when clad in his submarine armor he becomes monstrous in size and appearance. A more singular sight than to see him roll or tumble into the water and disappear from sight, or popping up, blowing, as the air escapes from his helmet, like a young whale, can scarcely be imagined. Waters has his own ideas of a joke, and when he has a curious audience will wave his scraper about as he "bobs around" on the water, with the air of a veritable river god.

The diver, when clothed in his armor is weighed with one hundred and eighty-five pounds. Besides this armor he has two leaden pads, fitting to his breast and back. The soles of his shoes are of lead, an inch and a half thick. All this weight is needed to overcome the buoyancy given by the mass of air forced into the armor and dress, the latter of India rubber, worn by the diver. When below the surface he can instantly bring himself up by closing momentarily the aperture in the helmet for the escape of the air. His buoyancy is immediately increased, and he pops up like a cork and floats at will upon the surface.

The work of scraping the bottoms of the monitors is very arduous. The diver sits upon

a spar, lashed athwart the bottom of the vessel, so arranged as to be moved as the work progresses, and with a scraper fixed to a long handle works on both sides of himself as far as he can reach. The mass of oysters that become attached to the iron hulls of one of the monitors, even during one summer here, is immense. By actual measurement it was estimated that two hundred and fifty bushels of oysters, shells and sea grass were taken from the bottom of the *Montauk* alone. The captains of the monitors have sometimes indulged in the novelty of a mess of oysters raised on the hulls of their own vessels.

Besides cleaning the monitors the divers perform other important services. They have ransacked the interior of the *Keokuk*, attached buoys to lost anchors, and made under water examinations of the rebel obstructions. Waters recently examined the sunken *Weehawken* and met an unusual danger for even his perilous calling. The sea was so violent that he was twice thrown from the deck of the monitor. Finally getting hold of the iron ladder he climbed to the top of the turret, when a heavy sea cast him inside the turret between the guns. Fearing that his air hose would become entangled, he made his way out with all possible speed, and was forced to give up his investigations until calmer weather offered a more favorable opportunity.

To "The Monitor Boys"

Note: "The Monitor Boys" was a signature used by the Monitor's crew in a letter to Captain John Worden after he left the Monitor as a result of wounds that occurred during the Monitor's battle with the CSS Virginia. The letter lamented Worden's departure and stated the hopes of the crew that he would join them again soon.

On June 27, Navy divers placed a time capsule on the wreck of the USS *Monitor*. The capsule was placed in memory of the *Monitor's* officers and crew from the officers and crew of the USS *Grasp*, divers from the Navy's Mobile Diving and Salvage Unit Two, *Monitor* Sanctuary staff, The Mariners' Museum, and the US Coast Guard. The idea of the time capsule was proposed by one of the crew of the *Grasp* who wanted to make the gesture in recognition of the men who perished the night the *Monitor* sank.

The capsule contains a number of items including a Navy diver's pin, a copy of Ericsson's plans of the *Monitor* signed by expedition personnel, a Huntington medal from The Mariners' Museum, and a US Coast Guard flag signed by the men assigned to Coast Guard Group Cape Hatteras. The items were placed in a water-tight container made of heavy-duty PVC that will in no way react with the iron or other materials on the wreck.

Monitor Sanctuary Celebrates 25th Anniversary

On January 30, 1975, the *Monitor* was designated the nation's first marine sanctuary. A quarter-century of research, education, and outreach was celebrated in January 2000 at an event at The Mariners' Museum. The ceremony was held in the *Monitor* exhibit of the Museum's "Defending the Seas" gallery.

Despite a storm that blanketed much of the east coast with snow and ice, causing delays or cancellations of travel plans for some of the invited speakers and guests, the ceremony was held as planned. In attendance were managers from other sanctuaries and administrators and staff from the National Marine Sanctuary Program in Silver Spring, MD. Speakers included John Hightower, President and CEO of the Mariners' Museum; CAPT Ted Lillestolen, Deputy Assistant Administrator of National Ocean Services; CDR Craig McLean, Deputy Director of the National Marine Sanctuary Program, and John Broadwater, *Monitor* Sanctuary Manager; and CAPT Christopher Murray of NAVSEA, U.S. Navy. NOAA and the Navy announced plans to continue joint expeditions to the *Monitor* for the purpose of recovering the *Monitor's* engine and turret. The Museum hosted a reception following the ceremony.

Commerce Department Awards Bronze Medals To John D. Broadwater and Dina B. Hill

The U.S. Department of Commerce has awarded Bronze Medals to John D. Broadwater and Dina B. Hill of the National Oceanic and Atmospheric Administration's National Marine Sanctuary Program for exemplary leadership in developing and implementing the USS *Monitor* stabilization and recovery effort.

Dr. Broadwater, who serves as manager of the *Monitor* National Marine Sanctuary, and Ms. Hill, education coordinator for the Sanctuary, were presented the awards on Oct. 19 by NOAA Administrator, D. James Baker at a ceremony in College Park, Md.

Broadwater and Hill lead NOAA's current efforts to prevent the disintegration of the famous Civil War ironclad warship USS *Monitor* through a program of hull stabilization and recovery of selected components for exhibit. Plans for 2001 include recovery of the *Monitor's* engine, which will be conserved and displayed at The Mariners' Museum, Newport News, Virginia.

The Bronze Medal is the highest honorary award given by NOAA, an agency of the U.S. Department of Commerce. It is granted by the Administrator for a significant contribution to NOAA or the Department.

You can follow the *Monitor* 2001 Expeditions by visiting a new web site at <http://oceanexplorer.noaa.gov/>.

The site will include background information, interesting factoids and updates on the progress of engine recovery.

Cheesebox is published by The Mariners' Museum, Newport News, Virginia; Vol. XI, No. 1, April 2001. Dina B. Hill, *Monitor* National Marine Sanctuary. Funding provided by the National Oceanic and Atmospheric Administration in the amount of \$1,600.



Editor's Corner

As you read this issue of *Cheesebox*, NOAA and its partners are moving steadily towards recovery of the *Monitor's* engine this summer, and recovery of the gun turret next year. The *Monitor* Sanctuary staff has always managed to stay busy but recent years have surpassed all previous levels of activity.

This is a bittersweet time for me. I have resigned my position as education coordinator of the *Monitor* Sanctuary effective June 1. After more than twenty-five years of being involved with the *Monitor*, it is time to move on to other things. I became a grandmother in 1999, and I want to spend more time with my grandson. Those of you who have grandchildren know what wonderful blessings they are, and I do not want to miss watching him grow. I also want to spend more time with my butterfly and herb gardens, and the creatures who visit there. The roses are really quite wonderful when you take the time to smell them.

This is a time of great reflection. My involvement with the *Monitor* has provided me with associations with a wide variety of people, some notable, some now gone, and all—well, okay, most—truly enjoyable.

I have been remembering the ones who are no longer with us. I remember John Newton, one of the discoverers of the wreck of the *Monitor* in 1973, and his commanding speaking presence. It did not matter so much what he said; audiences were mesmerized by his voice and projection. And there was Harold "Doc" Edgerton, father of the strobe light and inventor of the camera that located the wreck of the *Monitor*. Doc was a true genius and funny, enthusiastic and friendly, whether working on proposals for *Monitor* research or planning searches for the Loch Ness monster. He was a great pleasure to know. And of course there was Ernest Peterkin. Like the others, Pete left us all too soon, before the major recoveries began. Since his expertise was in how the *Monitor* was built, Pete would have been up to his ears in our recovery

plans and loving every minute of it.

I have been remembering Dr. Nancy Foster, who was head of the Sanctuary Program for several years and who was always a supporter of the program no matter where she was. Dr. Foster was a strong, dynamic leader and a remarkable woman. We lost a great friend with her passing last year. My memories of her are among my most treasured.

I have been remembering the people who have offered their expertise to the *Monitor* over the years. We have worked with archaeologists, conservators, corrosion engineers, historians, oceanographers, structural engineers, and technical divers from all over the United States. Each brought a slightly different perspective to the project and significantly broadened our capabilities. I have enjoyed working with all of you.

I have been remembering the members of the news media who visited our *Monitor* expeditions over the years. I am always amazed at the interest that work on the *Monitor* generates and grateful for the good relationship I have had with the media. National and local representatives of television, newspapers, and radio come to Hatteras, ride for two hours through very rough seas, spend long periods of time bouncing around on a ship to get their photographs and interviews, ride another two hours back through rougher seas, and maintain good attitudes about it all. It has been a pleasure working with such a great group of people. And thank you all for getting the quotes right!

And I have been thinking about the heart and soul of the *Monitor*: you, the readers, the people who have encouraged and supported us and our efforts to save the *Monitor* for future generations. Thank you for making my job fun and interesting and challenging.

To all of you, and so many more, I will miss you very much. But my grandson—and the roses—beckon.

Dina Hill